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Research Product 84-13

M1 Tank Gunnery Multiple Returns

ARI Field Unit at Fort Knox, Kentucky
Training Research Laboratory

May 1984

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) Research was conducted to develop tank gunnery sustainment training materials for M1 Abrams tank crewmembers. The research product developed consists of a knowledge section detailing operation of the laser rangefinder system and operator responses, and a battlefield scenario section wherein tank commanders and gunners can practice the appropriate responses to pictorially presented situations. Key words: Army training;			

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M1 Tank Gunnery Multiple Returns

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M1 TANK GUNNERY MULTIPLE RETURNS



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RP 84-13

M1 TANK GUNNERY-MULTIPLE RETURNS

USER'S GUIDE

This booklet deals with multiple range returns that may occur when ranging to a target using the laser rangefinder (LRF). When you have finished the booklet, you will be able to:

TAKE THE CORRECT ACTIONS IF A MULTIPLE RETURN SYMBOL AP-
PEARS IN THE GPS(E) OR THE RANGE ANNOUNCED BY THE GUNNER
IS CONSIDERED INCORRECT.

The booklet consists of two sections. Section I is the information part of the booklet. It will discuss issues related to multiple returns. These issues include:

- A.● RANGE RETURNS & GPS (E) SYMBOLOGY
- B.● LRF SETTINGS
- C.● DEALING WITH MULTIPLE RETURNS

Review questions are presented after each issue. You should answer each of these questions, then check your answers with the Answer Key provided. If you need additional information, you should refer to the M1 Technical Manual (TM 9-2350-255-10) or the M1 Tank Combat Tables (FM 17-12-1). Section II contains a number of battlefield scenarios. These scenarios will give you practice in dealing with multiple returns under battlefield situations. Each scenario contains:

- A PICTURE OF THE BATTLEFIELD SITUATION
- A SHORT WRITTEN DESCRIPTION OF THE BATTLEFIELD SITUATION AND THE STATUS OF YOUR TANK
- A QUESTION FOR YOU TO ANSWER

HOW TO USE THE BATTLEFIELD SCENARIOS

1. Look at the scenario picture.
2. Read the short written description.
3. Answer the scenario question.

- SOME QUESTIONS ARE FOLLOWED BY A LIST OF POSSIBLE ANSWERS. FOR THESE QUESTIONS, YOU SHOULD SELECT THE CORRECT ANSWER.
- SOME QUESTIONS DO NOT HAVE A LIST OF POSSIBLE ANSWERS. FOR THESE QUESTIONS, YOU MUST PROVIDE YOUR OWN ANSWER.

4. Check your answer with the Answer Key on the page following the scenario.
5. Proceed to the next scenario.

BEFORE YOU USE THIS BOOKLET

Before using this booklet, be sure you can do the following:

- OPERATE THE LRF
- PERFORM NORMAL MODE GUNNERY

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SECTION I

MULTIPLE RETURNS INFORMATION

A. RANGE RETURNS & GPS(E) SYMBOLOGY

● SINGLE RETURN

The LRF can determine the range to targets located between 200 and 8000 meters with an accuracy of plus or minus 10 meters. When you or the gunner lases to a target you are really sending out a beam of light energy. Sometimes this beam will hit only the target area and be reflected back to the LRF receiver. When this happens, only one range return will be displayed in the GPS(E).

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● MULTIPLE RETURNS

At other times you will lase to a target and part of the laser beam will hit objects in front or behind it. The LRF receiver will sense "returns" from all objects hit, not just those that hit the target. When this happens the range return displayed in the GPS(E) will have a bar or line above it. This tells you that more than one return was actually sensed. This is called a multiple return.

● CAUSES OF MULTIPLE RETURNS

Laser energy can be reflected, absorbed, or scattered, depending on amount of beam obstruction and how the objects encountered reflect it. Included among these objects are:

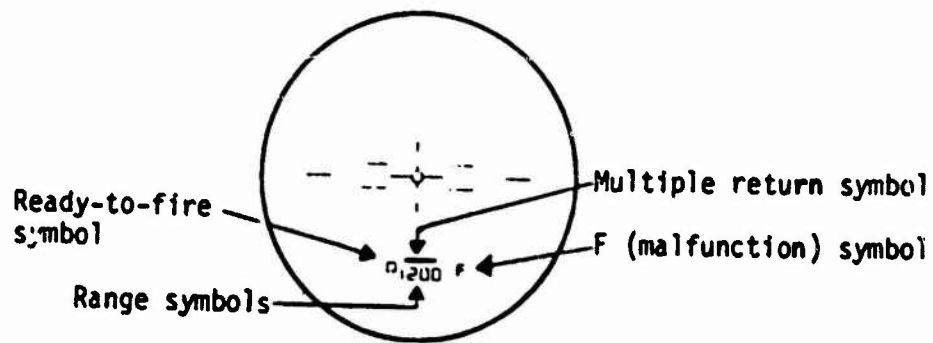
- | | |
|----------------------------|----------------|
| ● Trees/Bushes | ● Falling Snow |
| ● Fog/Smoke | ● Heavy Rain |
| ● Blowing sand, dirt, etc. | |

● GPS (E) SYMBOLOGY

There are four symbols that can be displayed in the GPS(E). They are:

- | |
|--------------------------|
| ● Ready-to-fire symbol |
| ● F (malfunction) symbol |
| ● Multiple return symbol |
| ● Range symbols |

These symbols are shown in the picture below:



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● MULTIPLE RETURN SYMBOL

When the laser receives more than one return, the multiple return symbol is displayed in the GPS(E). As shown in the picture above, the multiple return symbol is a bar or line that appears above the range numbers in the GPS(E). This symbol is called the multiple return bar.

Remember. The multiple return bar will only appear when there is more than one range return sensed by the LRF receiver.

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RANGE RETURNS & GPS SYMBOLOGY

QUESTIONS

1. The LRF can determine the range to targets located between:
 - A. 200 and 700 meters.
 - B. 290 and 8090 meters.
 - C. 290 and 8000 meters.
 - D. 200 and 8000 meters.
2. When the laser beam hits more than one object, the GPS(E) will display a:
 - A. Multiple target symbol.
 - B. Multiple return symbol.
 - C. Multiple object symbol.
 - D. Multiple lase symbol.

3. What objects can reflect, absorb, or scatter the laser beam?
- A. Vehicles.
 - B. Trees.
 - C. Heavy fog.
 - D. All of the above.
4. How many symbols are displayed in the GPS(E)?
- A. One
 - B. Two
 - C. Three
 - D. Four
5. What symbol is used to indicate multiple return?
- A. A bar below the range display.
 - B. An F symbol.
 - C. A bar above the range display.
 - D. Bars above and below the range display.

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6. When does the multiple return bar appear in the GPS(E)?
- A. When the F symbol comes on.
 - B. When the ready-to-fire symbol appears.
 - C. When the range is displayed at the bottom of the GPS(E).
 - D. When the LRF receives more than one return.

Answers: 1.0 2.8 3.0 4.0 5.C 6.D

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B. LRF SETTINGS

The laser rangefinder (LRF) can be set to one of three positions using the laser RANGE switch. These LRF settings are:

- SAFE
- ARM LAST RTN
- ARM 1ST RTN

● SAFE

The RANGE switch should be in the SAFE position when the laser rangefinder is not being used. This prevents accidental firing of the laser beam which can cause serious eye damage.

- ARM LAST RTN (RETURN)

When the LRF is in the ARM LAST RTN position, you will obtain the correct range to the target more than 90% of the time under most battlefield situations. In this position, the range displayed in the GPSE will be the last object within the path of the laser beam. In other words, you will obtain the correct range to the target if the target is the last object hit by the laser beam. If the laser beam "spills over" the target, either because the beam is wider than the target or the beam did not hit the target center of mass, you will receive an incorrect range to the target. A multiple return symbol will also appear above the range displayed in the GPS(E).

There are several situations that require you to use the ARM LAST RTN position. For example, you would use ARM LAST RTN if:

- Dust or smoke is blowing across the battlefield.
- Bushes or trees are between you and the target.

- ARM 1ST RTN

The ARM 1ST RTN position will provide the range to the first object within the path of the laser beam. Therefore, when there are no objects between you and the target, set the laser RANGE switch to ARM 1ST RTN. Consider the following situation:

You want to range to a target that is 2500 meters away.
The target is located in front of several trees. There are no objects between you and the target.

In this situation, you know that the target is the closest object to you. You also know that there are no objects between you and the target to produce a multiple return. Therefore, the range GPS(E) will be correct. What happens if part of the laser beam "spills over" to the trees behind the target? YES, a multiple return bar will appear over the range displayed in the GPS(E). However, since the target is the first object within the path of the laser beam, the range shown remains the correct range to the target.

There are several situations that require you to use the ARM 1ST RTN position. For example, you would use the ARM 1ST RTN if:

- There are no objects between you and the target.
- When the target is extremely small.
- When the target is at an extended range (the entire target appears in aiming circle).

LRF SETTINGS

QUESTIONS

1. In which of the following positions should the laser RANGE switch be set when the LRF is not being used?
 - A. SAFE
 - B. ARM LAST RTN
 - C. ARM 1ST RTN

2. In which of the following positions should the laser RANGE switch be set for field situations?
 - A. SAFE
 - B. ARM LAST RTN
 - C. ARM 1ST RTN

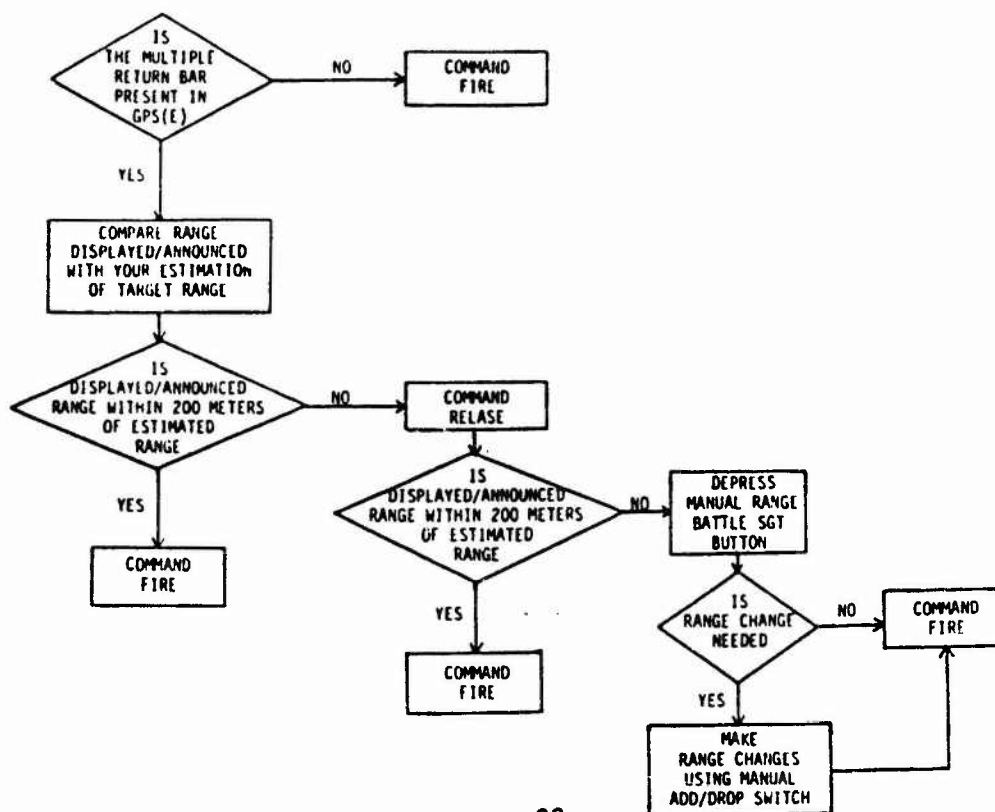
3. In which position should the laser RANGE switch be set when there is dense smoke between you and the target?
- A. SAFE
 - B. ARM LAST RTN
 - C. ARM 1ST RTN
4. What range will be displayed in the GPSE when lasing to a target in the ARM 1ST RTN position?
- A. First range sensed by the LRF receiver.
 - B. Lost range sensed by the LRF receiver.
 - C. Battle range manually indexed into fire control system.
 - D. Range display in GPSE is "blank".

Answers: 1.A 2.B 3.A 4.A

C. MULTIPLE RETURN STRATEGIES

You know by now that the multiple return bar will not appear in the GPS(E) every time you lase. When you get a good lase to the target, a single range return, you simply continue with the gunnery engagement procedures. However, what should you do if you lase and the multiple return bar appears above the range displayed?

To answer this question, review the following flowchart.



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As you can see, the actions the tank commander (TC) must take when dealing with multiple returns depend on how he answers the questions in the flowchart. The following paragraph will explain the multiple return strategy the TC must follow.

1. Check to see if the multiple return bar is displayed in the GPSE. If you are in the fully open or protected open hatch position, this step is omitted. The gunner will announce the range.
2. Compare your estimate of target range with the range displayed in the GPSE or announced by the gunner. You must then decide if the range displayed/announced is correct.
3. When the displayed/announced range is within 200 meters of your estimated range you know that the correct range data has been fed into the computer. If the displayed/announced range is much greater or much less than your estimated range, you know that the LRF receiver has sensed a return from something other than the target.

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4. If the range is correct, issue the command "FIRE." If the range is not correct, issue the command "RELEASE."
5. If the new displayed/announced range is correct, issue the command "FIRE." If it is still not correct, depress the MANUAL RANGE BATTLE SGT button. If necessary, use the MANUAL RANGE ADD/DROP toggle switch to make range changes. When satisfied that range displayed in GPSE is correct, issue the command "FIRE."

D. SPECIAL CASES

● FLASHING ZEROS

Sometimes you might lose to a target and flashing "0000" appear. This can mean one of three things:

- ALL returns are less than 200 meters away.
- The target is farther than 8000 meters away.
- There is not enough light for the LRF receiver to calculate the range.

Whenever flashing zeros are displayed or announced by the gunner, command the gunner to RELEASE.

* * * * *

The information provided in this section does not cover everything you need to know about the LRF. For more information, refer to TM 9-2350-255-10 (Operators Manual) and FM 17-12-1 (Tank Combat Tables) for the M1.

MULTIPLE RETURN STRATEGIES

QUESTIONS

1. What action must the TC take after noticing a multiple return bar in the GPSE?
 - A. Compare displayed range with estimated range.
 - B. Command "FIRE".
 - C. Command "RELEASE".
 - D. Depress MANUAL RANGE BATTLE SGT button.
2. How close or accurate should the displayed/announced range be to the estimated range before issuing the command "FIRE"?
 - A. 100 meters
 - B. 200 meters
 - C. 300 meters
 - D. 400 meters

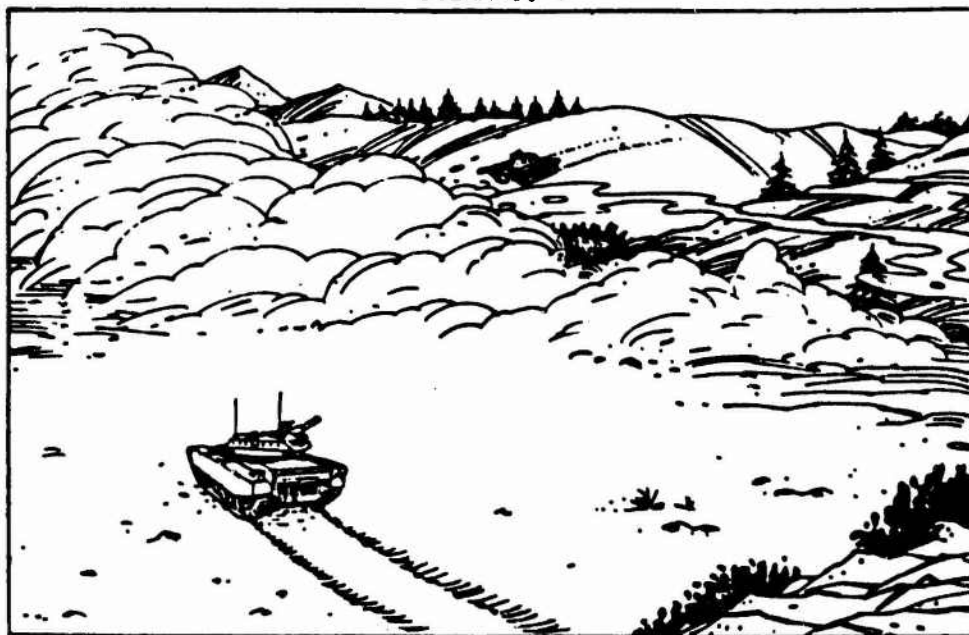
3. If the displayed range is not close (accurate) to the estimated range, the TC should:
- A. Command "FIRE".
 - B. Set RANGE switch to ARM 1ST RETURN.
 - C. Override the gunner and fire.
 - D. Command "RELEASE".
4. If the second range displayed/announced is still not correct, the TC should:
- A. Override the gunner; lay, lase, and fire.
 - B. Command "RELEASE".
 - C. Depress MANUAL RANGE BATTLE SGT button.
 - D. Command "FIRE AND ADJUST".

Answers: 1.A 2.B 3.C 4.D

SECTION II

MULTIPLE RETURN BATTLEFIELD SCENARIOS

SCENARIO 1



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THE SITUATION

- You are buttoned-up in a deliberate attack mode.
- Dense smoke is blowing across the battlefield.
- You detect a T-55 about 1890 meters away; he sees you.
- You announce GUNNER, SABOT, MOVING TANK.
- He lases to target center of mass.
- 2500 and multiple return bar appears in GPS(E).

What should you, the tank commander, do next?

A

Command
RELEASE

B

Command
DEGRADED,
FIRE

C

Command
FIRE

D

Command
SELECT
ARM 1ST
RTN

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SCENARIO 1 ANSWER

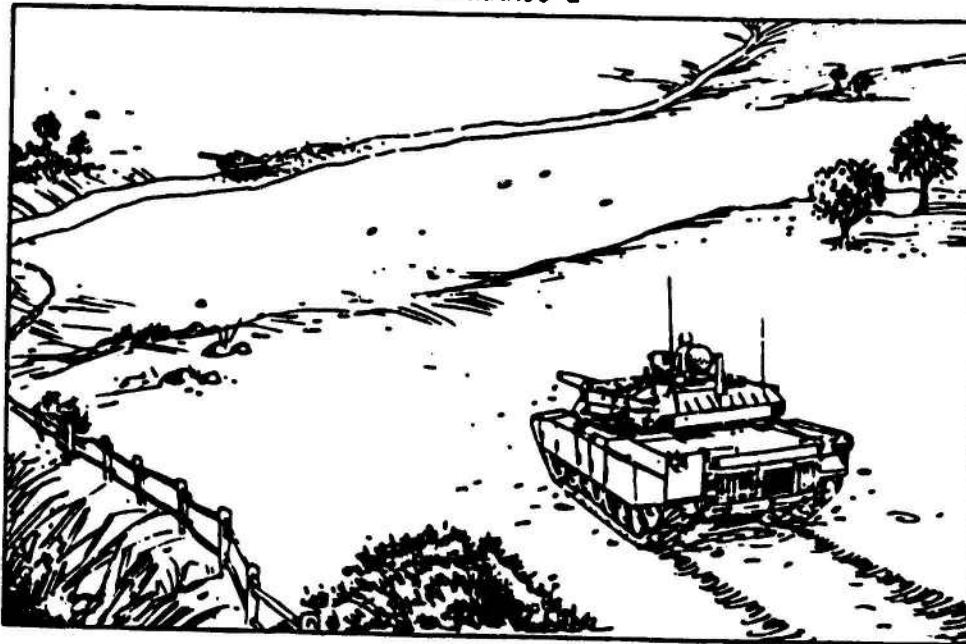
The correct answer is A: Command RELEASE.

Remember. When you receive a multiple return indication in the GPS(E) on the first lase, and the displayed range is not within 200 meters, you must have the gunner relase to the target.

WRONG ANSWERS

- B. The LRF has not failed if multiple returns are received after lasing.
- C. This would only result in a first round miss.
- D. The TC should have had the gunner do this BEFORE the engagement started.

SCENARIO 2



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THE SITUATION

- M1 is traveling across open ground; you are in fully-up position.
- You detect a T-62 at about 1800 meters, he sees you.
- You command GUNNER, SABOT, MOVING TANK.
- There is no smoke, fog, or obstacles between you and the T-62.
- Gunner lases to target center of mass
- Range displayed in GPS(E) is 1690 with a multiple return bar.

What should you, the tank commander, do next?

A
Command
RELEASE

B
Command
FIRE

C
Add range
using ADD/
DROP toggle
switch

D
Depress MANUAL
RANGE BATTLE
SGT button

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SCENARIO 2 ANSWER

You should have selected B: Command FIRE.

Remember. If the target is within 200 meters of your estimated range, you should engage the target (FIRE) rather than having the gunner release. At this range you should obtain a first round hit firing SABOT or HEAT.

WRONG ANSWERS

- A. Target is within 200 meters of your estimated range.
- C. Must do "D" first. Even so, time consuming and not necessary to obtain a 1st round hit.
- D. This would only give you either 900 or 1200 meters; shorter than range displayed.

SCENARIO 3



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THE SITUATION

- You are well concealed in a hull down position, fully open hatch.
- An APC is stopped at about 1500 meters, he does not see you.
- The area has fog drifting between you and the target.
- You command GUNNER, HEAT, APC.
- Gunner lases to the target twice.
- Both times range announced by the gunner was 400-500 meters short of your estimate.

What should you, the tank commander, do next?

A
Command
RELEASE

B
Command
FIRE

C
Depress
MANUAL RANGE
BATTLE SGT
button

D
Add range
using ADD/
DROP switch

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SCENARIO 3 ANSWER

The correct answer is C: Depress MANUAL RANGE BATTLE SGT button.

Remember. When the range announced by the gunner is still not correct after two consecutive lasings, the tank commander must depress the MANUAL RANGE BATTLE SGT button. This automatically feeds a manually indexed battle range into the fire control system for ammo selected. If necessary, the TC may adjust/change range using the MANUAL ADD/DROP toggle switch.

WRONG ANSWERS

- A. Not according to multiple return strategy.
- B. Would only result in a probable first round miss.
- D. Only if "C" was performed first and if necessary, i.e., still more than or less than 200 meters from your estimated range.

SCENARIO 4



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THE SITUATION

- You are well concealed and in a buttoned-up position.
- A truck at about 900 meters has been spotted.
- He has not seen you.
- You command GUNNER, COAX, MOVING TRUCK.
- Gunner lases to the truck; 500, with a multiple return bar, appears in GPS(E).

What should you, the tank commander, do next?

(No choices this time. Figure it out, and write your answers below BEFORE turning the page.)

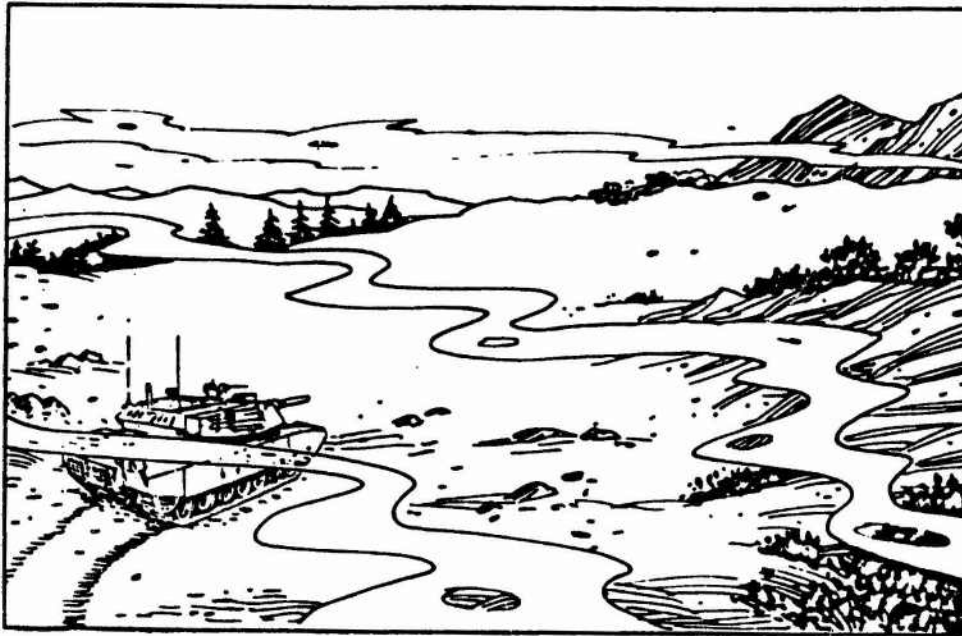
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SCENARIO 4 ANSWER

The correct answer is: Command RELEASE, since your estimate of the range differs by more than 200 meters from the range shown in the GPS(E).

Remember. In an engagement using the coax, the gunner must lase to the target. If he does not, the previous range displayed in the GPS(E) will automatically become the range part of the fire control solution.

SCENARIO 5



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THE SITUATION

- M1 is moving across open terrain; you are buttoned-up.
- Two T-62s are detected at about 2000 meters; they see you.
- You command GUNNER, SABOT, TWO MOVING TANKS, LEAD TANK.
- Scattered fog is present throughout the battlefield.
- Gunner lases to the target with the RANGE switch in ARM LAST RTN.
- 2010 with a multiple return bar appears in the GPS.

What should you, the tank commander, do next?

(Write down your answer, then turn the page.)

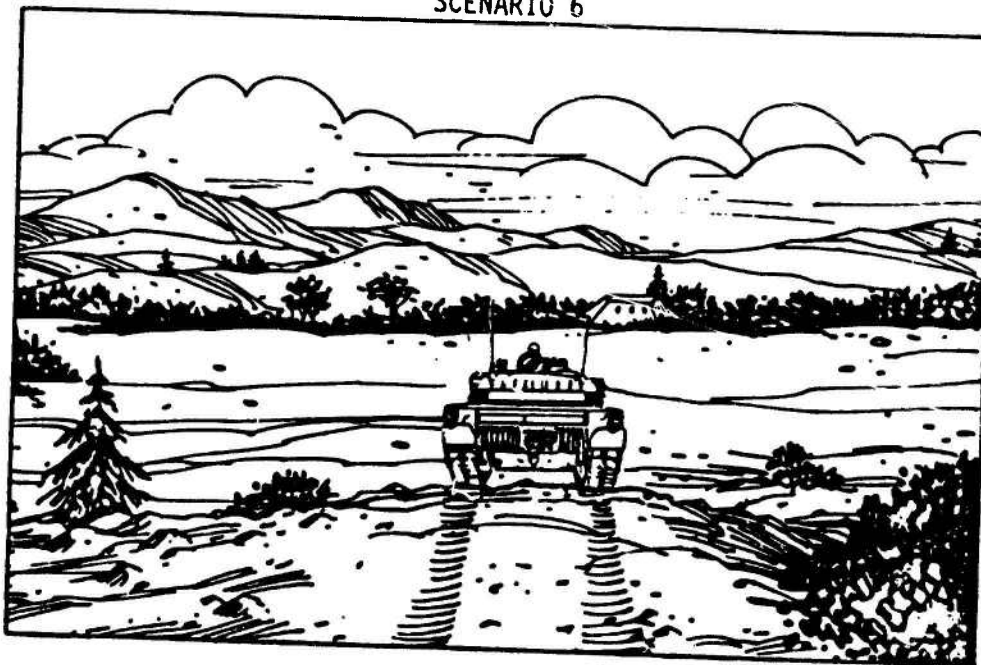
47

SCENARIO 5 ANSWER

The correct answer is: Command FIRE!

Remember. Since the range displayed (2010 meters) is within 200 meters of your estimated range (2000 meters) you should go ahead and fire. The multiple returns received were probably the result of the laser beam being reflected by the fog.

SCENARIO 6



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THE SITUATION

- You have just crossed over a ridge in fully opened hatch position.
- You spot a bunker with binoculars at estimated range of 1300 meters.
- There are no obstacles between you and the bunker.
- Gunner lases to the target on command GUNNER, SABOT, BUNKER.
- He announces ONE SEVEN SEVEN ZERO.

What should you, the tank commander, do next? In what position is the laser RANGE switch set?

(Write down your answers, then turn the page.)

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SCENARIO 6 ANSWER

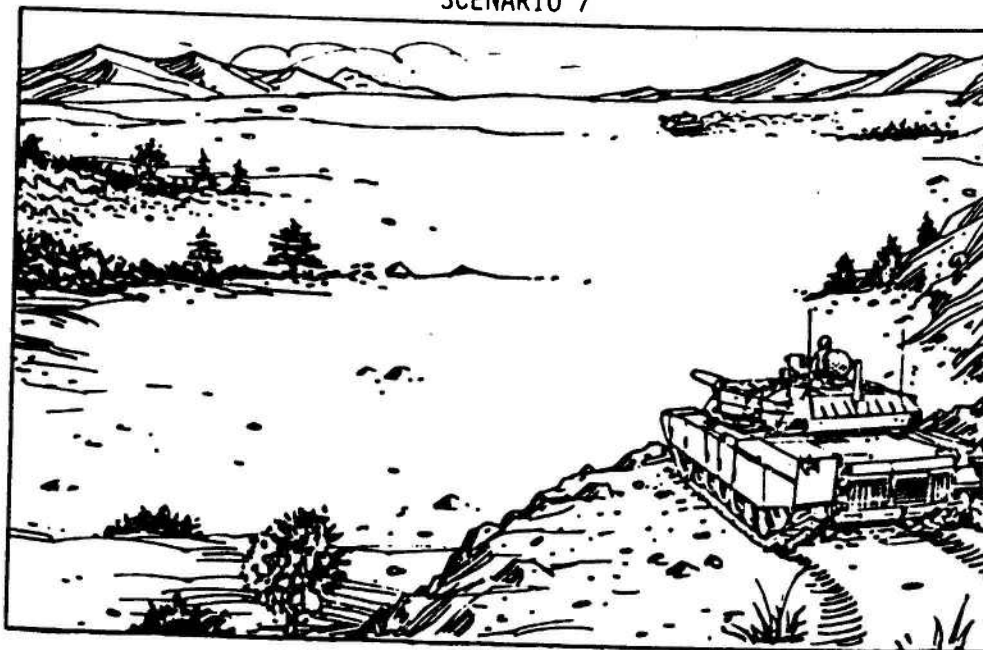
You should have said: Command RELEASE.

- Because the range displayed was much greater (470 meters) than your estimated range, the LRF probably received a return from an object beyond the bunker. Have the gunner relay and release again.

and

- Since there are no obstacles between you and the bunker, the laser RANGE switch should be in ARM 1ST RTN.

SCENARIO 7



5A

THE SITUATION

- Your M1 is in a fully-opened hatch position, unprotected.
- A moving SP-122 howitzer is detected.
- Estimated range to the howitzer is about 3000 meters.
- No objects are present between you and the target.
- You command GUNNER, SABOT, TANK.
- Gunner announces TWO EIGHT HUNDRED.

What should you, the tank commander, do next? In what position
should the laser RANGE switch be set?

(Write down your answers, then turn the page.)

SCENARIO 7 ANSWER

The correct answers are: Command FIRE.

- The range announced by the gunner is within 200 meters of your estimated range. Therefore, there is no need to rerange.

and

- Because there are no objects present between you and the target, ARM 1ST RTN can be used. Also, target is at an extended range. If in ARM LAST RTN, "spill over" will be quite possible.

SCENARIO 8



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THE SITUATION

- M1 is hull-down, you are in fully-closed hatch position.
- A moving truck is detected at about 800 meters.
- Heavy wind and dust is blowing.
- You command GUNNER, COAX, TRUCK; Gunner lases.
- Flashing "0000" appear in GPSE.

What should you, the tank commander, do next?

(Write down your answer, then turn the page.)

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SCENARIO 8 ANSWER

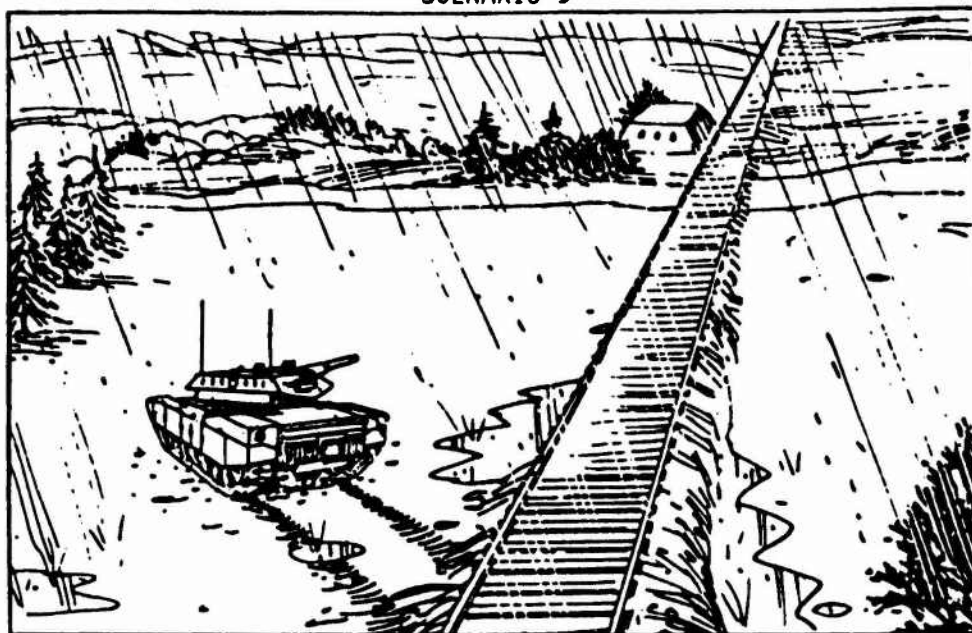
The correct answer is: Command RELEASE.

Remember. The flashing "0000" means:

- ALL targets are less than 200 meters away.
- Target is more than 8000 meters away.
- There is not enough light for the LRF receiver to calculate a range.

Because there is dust blowing, the flashing "0000" was probably the result of the laser beam being stopped by dust less than 200 meters away. Switch to ARM LAST RTN and attempt to lase again.

SCENARIO 9



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THE SITUATION

- You are moving across open ground in heavy rain buttoned-up.
- A bunker-type fortification is seen at about 1200 meters.
- You have been detected.
- You command GUNNER, SABOT, BUNKER.
- He lases to the bunker.
- 630 with a multiple return bar appears in GPS(E).

What should you, the tank commander, do next? In what position should the laser range switch be set?

(Write down your answers, then turn the page.)

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SCENARIO 9 ANSWER

The correct answer is: Command RELEASE.

- Whenever the initial range displayed/announced is not within 200 meters of your estimated range, command RELEASE.

and

- When there is heavy rain present you should lase to the target with the RANGE switch set in ARM LAST RTN. Heavy rain will cause a multiple return just like any other object present between the laser beam path and the target.

SCENARIO 10



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THE SITUATION

- M1 is moving across open terrain, you are in fully opened hatch position.
- A missile carrying vehicle is detected at about 2500 meters.
- No obstacles are present between you and the target.
- You command GUNNER, SABOT, ANTITANK.
- He lases to target and announces THREE FOUR ONE ZERO.

What should you, the tank commander, do next? In what position should the laser RANGE switch be set?

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SCENARIO 10 ANSWER

You should have said: Command RELEASE.

- Release whenever the initial range return is not within 200 meters of your range estimation.

and

- With no obstacles between you and the target, ARM 1ST RTN can be used. Also, target is at an extended range and laser beam may "spill over" to further objects behind it.

★ ★ ★ ★ ★

By now you should know the multiple returns strategy. If not, and as a final step in this self-study booklet, review the flowchart in Section I.

This M1 Multiple Returns booklet is a
prototype training document. For
comments or questions contact:

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